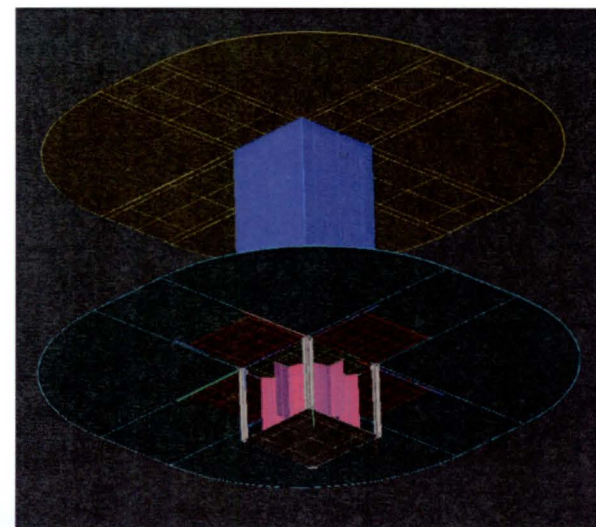
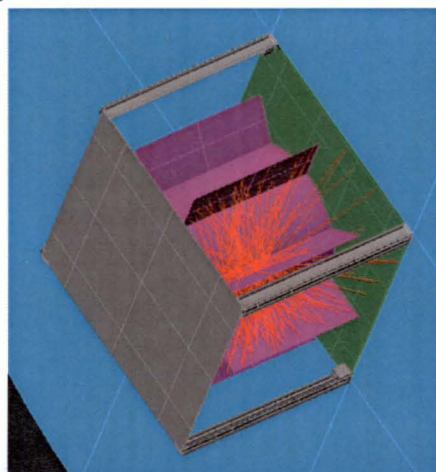
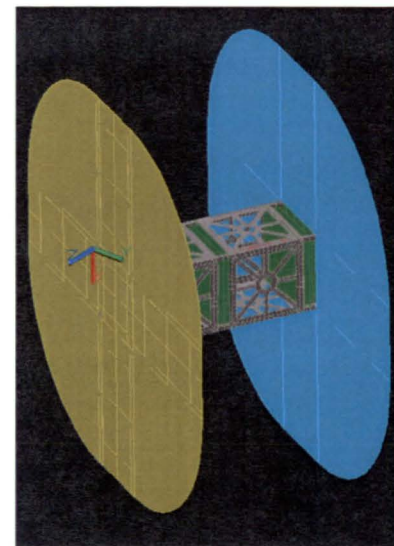


# CryoCube-1 Model Overview

- ThermalDesktop (SINDA / RadCAD) model
- Includes major structure, optical properties, experiment tank
- Standard orbital heating environment (Sun, Earth IR, albedo)
- 3U CubeSat (100 x 100 x 340 mm)
  - Sun shield / PV array combination (Dia. 500 mm)
  - Earth shield (Dia. 504 mm)
- Finned experiment tank
- Active louvers to expose tank to deep space
- Sun and Earth pointing behavior







# Model Assumptions

- Perfect pointing (Nadir in eclipse, Sun in sun)
- Circular orbit
- Simplified tank thermal model
- Estimated thermal contact conductance coefficients

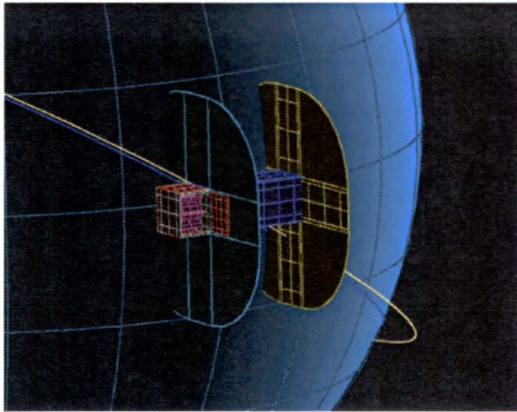
## Standard and conservative material properties

Material (Component)	Conductivity (W/m/K)	IR Emiss.	Solar Absorb.
7075 Al (Frame, side panels)	123 (Temp. Var.)	-	-
G-10 (Isolation standoffs)	0.6 (Temp. Var.)	-	-
304 Stainless (Tank)	14.64	-	-
MLI (Shields, etc.)	0 (Arithmetic nodes)	0.02 (Effective)	-
White Paint Z93SC55	-	0.940	0.140
Silicon Wafer (Solar cells)	125.5	0.560	0.600
Silver coated Teflon (Misc. surfaces)	-	0.680	.050

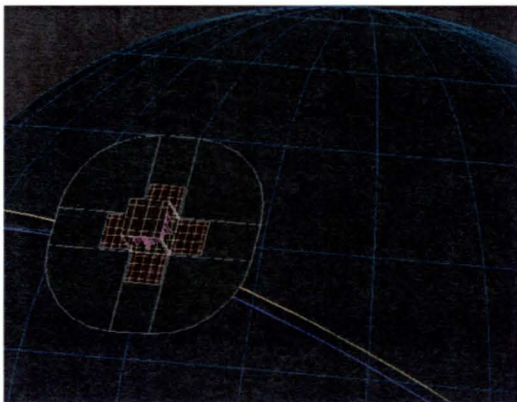


# Louver Opening Scheme

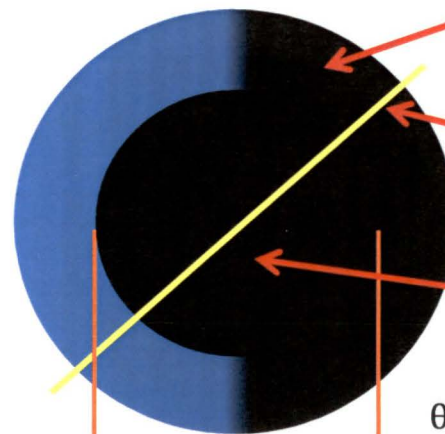
- Four independent louvers open based orbit location



Sun pointing – single louver open opposite earth



Nadir pointing– all louvers open

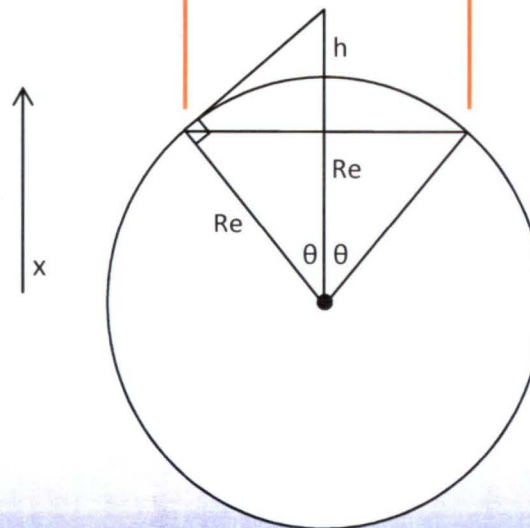


All louvers may open in eclipse

Orbit path

Single louver may open in concentric circle that orbit passes through

$$\theta = \arccos\left(\frac{Re}{Re + h}\right)$$

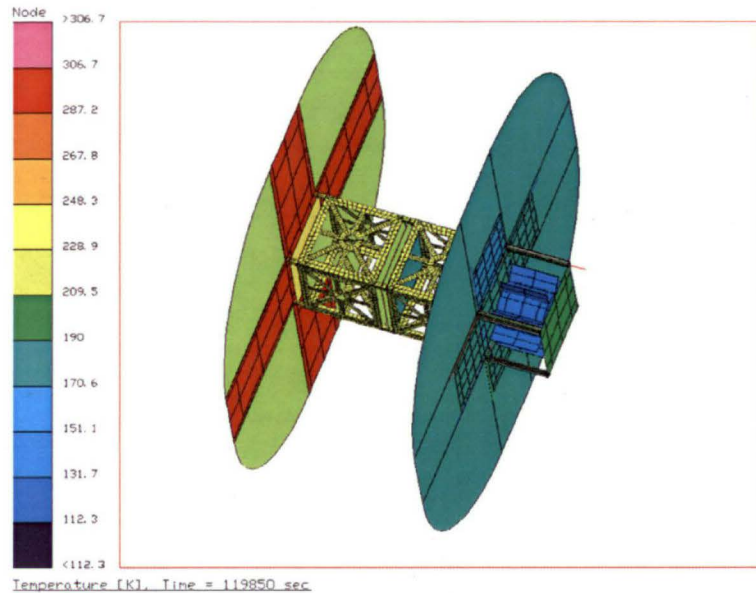


Door may open if unit vector  $X > \cos(\theta)$

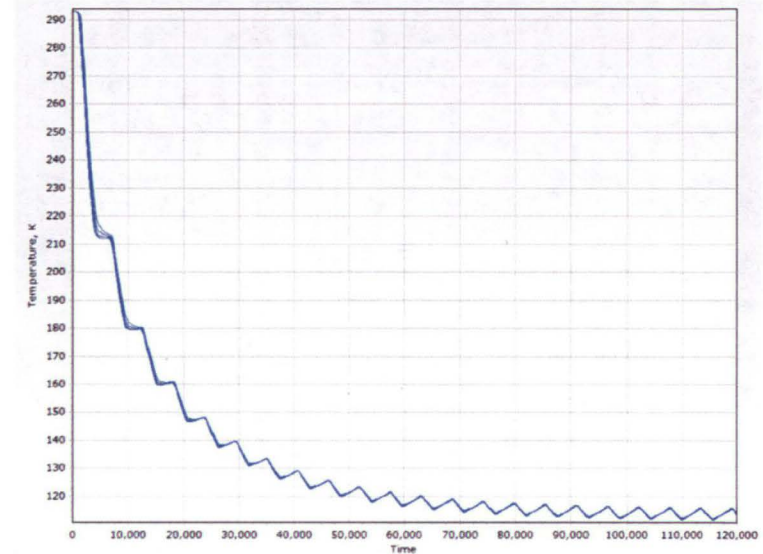
May multiply  $\theta$  by a factor to optimize louver opening boundaries

Optimal doors may utilize direct radiation sensing to activate louvers

# Preliminary Results



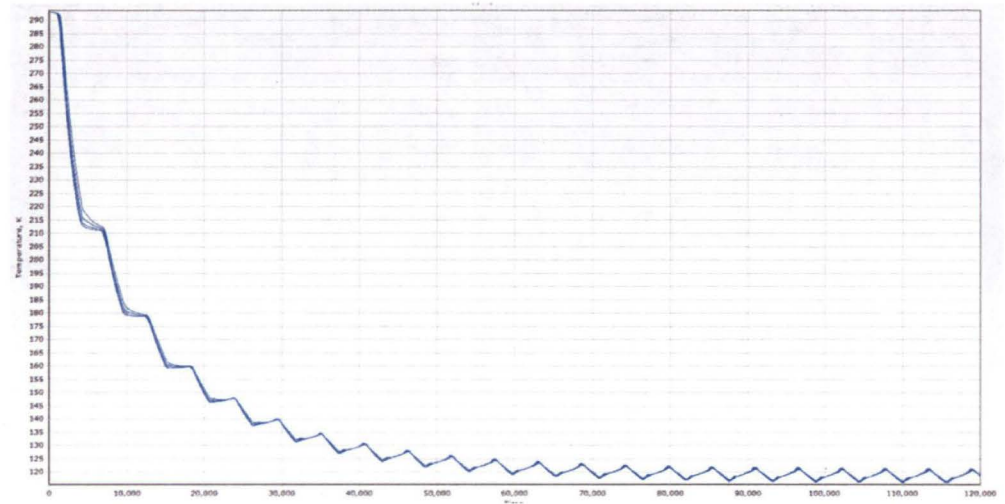
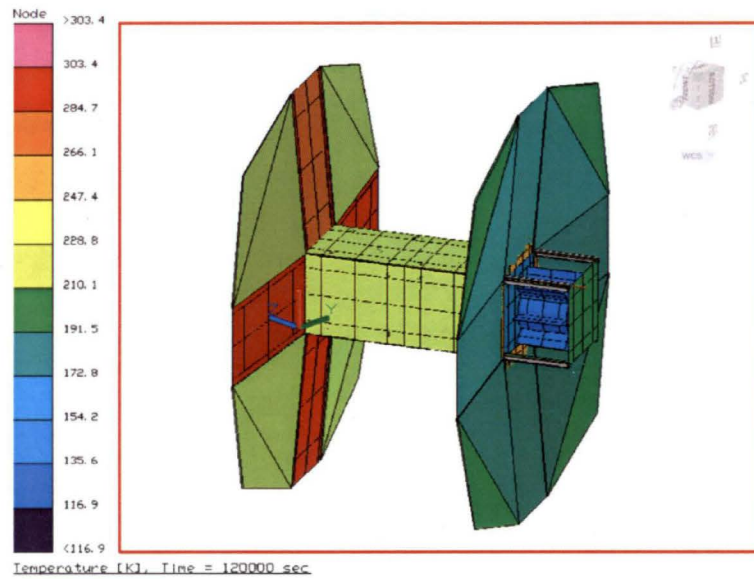
With conservative  
materials including  
MLI  $\epsilon^* = 0.02$



Low Temp. (K)	High Temp. (K)	Time to Steady (s)
112	115.5	110,000

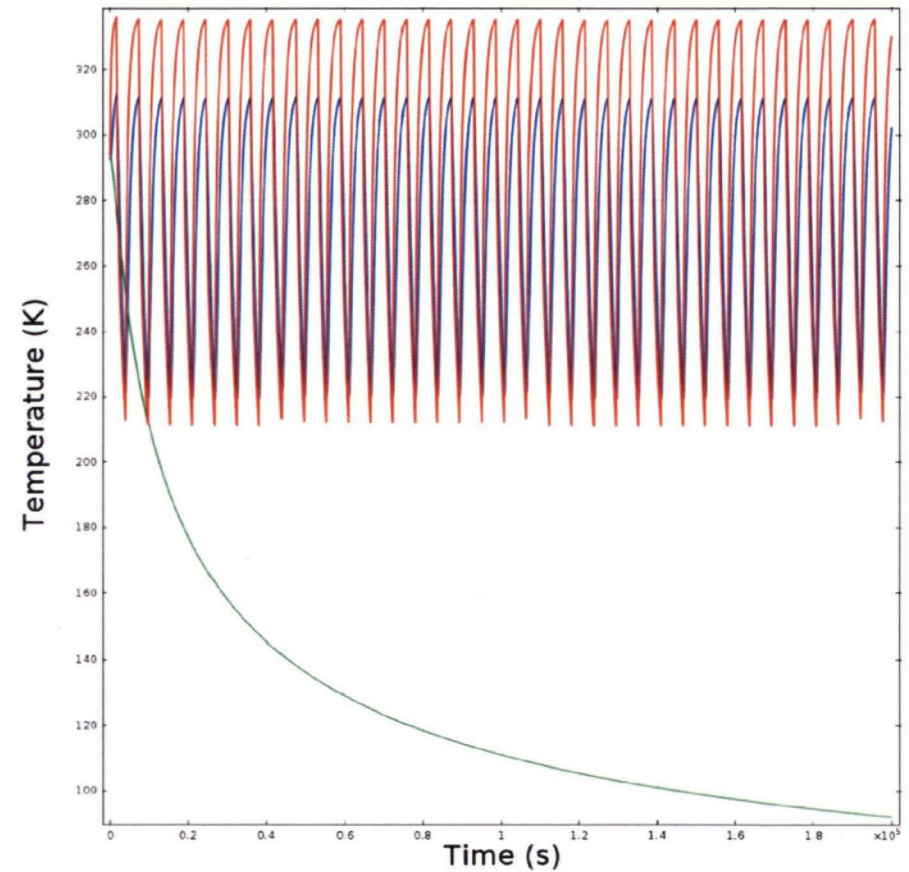
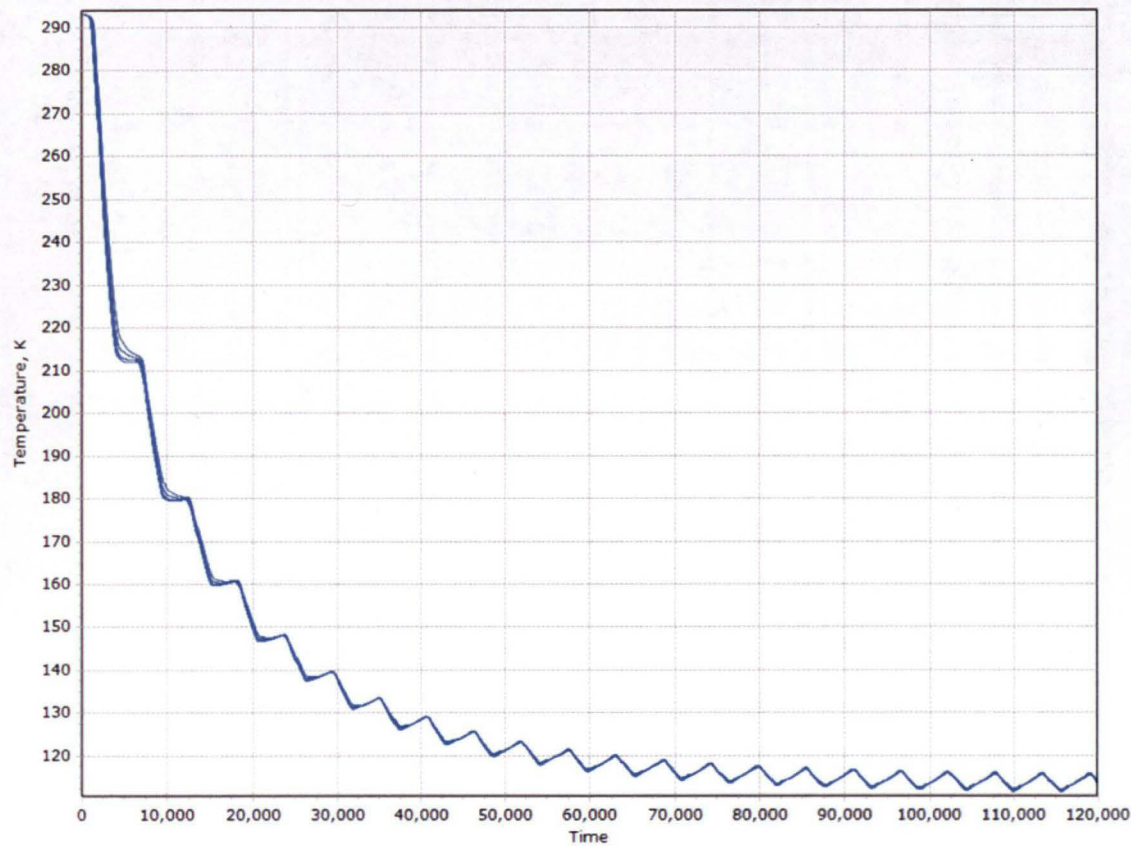


# Improved Coatings



Low Temp. (K)	High Temp. (K)	Time to Steady (s)
116.5	122	90,000

# Comparison to Multiphysics



Temperature of the solar arrays  
(red), bus unit (blue), and  
experiment tank (green)

MLI  $\epsilon^* = 0.01$